Understanding the Uneven Spread of HIV within Africa: Comparative Study of Biological, Behavioral and Contextual Factors in Rural Populations in Tanzania and Zimbabwe

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Understanding the Uneven Spread of HIV within Africa: Comparative Study of Biological, Behavioral and Contextual Factors in Rural Populations in Tanzania and Zimbabwe

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Abstract

Objective: To identify factors which explain differences in the spread of HIV between rural sub-Saharan African populations.

Methods: Ecological comparison of data from cross-sectional population-based HIV surveys in high and relatively low HIV prevalence rural areas in Zimbabwe (Manicaland) and Tanzania (Kisesa).

Results: HIV prevalence in Manicaland and Kisesa was 15.4% (*n* = 1,624) and 5.3% (*n* = 2,588) in men aged 17-44 years (odds ratio [OR] 3.3; 95% CI, 2.6-4.1) and 21.1% (*n* = 2,968) and 8.0% (*n* = 3,365) in women aged 15-44 years (OR, 3.1; 95% CI, 2.7-5.7). Marriage is later, spatial mobility more common, cohabitation with marital partners less frequent, education levels are higher, and male circumcision is less common in Manicaland. However, adjustment for differences in these factors increased the odds ratios for HIV infection in Manicaland *versus* Kisesa to 6.9 (95% CI, 4.9-9.8) and 4.8 (95% CI, 3.6-6.3) for men and women, respectively. STI levels were similar but syphilis was only common in Kisesa. Respondents in Kisesa started sex earlier and reported more sexual partners, while age differences between partners were similar.

Conclusion: The comparison of data on a wide range of underlying and proximate factors for the rural populations has resulted in few possible reasons for the much more extensive spread of HIV in Zimbabwe. The most important differences between the two populations pertained to underlying socio-demographic variables, such as the much lower levels of spousal cohabitation and the higher levels spatial mobility seen in Manicaland, although these differences did not translate into changes in reported sexual behavior.

Key Words: HIV prevalence - Epidemic size - Ecological study – Proximate determinants - Tanzania – Zimbabwe

The available data on HIV prevalence in sub-Saharan Africa indicate substantial heterogeneity in the spread of HIV across the continent. Large differences exist between and within countries and a range of biological, behavioral and contextual arguments have been advanced to explain these differences (1,2). Biological explanations include those that focus on different subtypes of HIV-1 and variation in the prevalence of other sexually transmitted infections (STI). Male circumcision, inextricably linked with cultural practices, is also considered an important biological factor. Differences in sexual practices, whether or not in relation to the response to the epidemic, have also been considered as important explaining factors, as have differences in underlying factors, such as mobility, infrastructure and poverty.

An important attempt to assess factors affecting the differential spread of HIV in urban Africa was made in a multi-centre study of four cities (3, 4). Two cities had very high prevalence of HIV in the general population (Kisumu, Kenya and Ndola, Zambia) and two cities had much lower prevalence (Yaounde, Cameroon and Cotonou, Benin). The study design combined ecological comparisons across populations with individual-level analyses within populations. It was concluded that differences affecting the efficiency of HIV transmission, notably lack of male circumcision and prevalence of ulcerative STIs, including Herpes Simplex Virus-2 (HSV-2), were the most important explanatory factors, while differences in high risk sexual behavior appeared to play a much smaller role. The main differences in the latter pertained to earlier sexual debut, earlier marriage and larger age difference between spouses in the high prevalence cities (3).

This paper presents results from a similar ecological comparison with individual-level analyses of two rural African populations with contrasting HIV prevalence levels. In rural Manicaland, in eastern Zimbabwe, HIV prevalence was about three times higher than in rural Kisesa in northwest Tanzania, during the mid- to late 1990s.

DATA AND METHODS

The Manicaland study data used in this paper were collected in a small-scale pilot study completed between February and April 1998 and a larger baseline survey for a cohort study that was undertaken between July 1998 and January 2000. The former was conducted in a subsistence farming area and a nearby commercial farming estate (5); the latter covered four subsistence farming areas, four commercial farming estates, two small towns and two small (tarred) roadside trading centers (6). In each case, eligible individual adult respondents (male and female local residents aged 17-54 years and 15-44 years, respectively) were identified in a preliminary household census. For better comparability with the data from Kisesa, the current study only utilized data from individuals who lived in the subsistence farming areas and the roadside trading or "business" centers.

Individuals who agreed to participate were interviewed on their demographic and socioeconomic characteristics and a sexual history was obtained. In the pilot survey, dried blood spot and urine samples were collected for the diagnosis of HIV and other STIs, such as gonorrhea, Chlamydia infection, trichomoniasis and HSV-2 (5). HIV antibody testing was done using Abbott third generation HIV 1&2 EIA (Abbott Laboratories, USA) and ICL dipstick HIV1&2 EIA (Immuno-Chemical Laboratory, Thailand). Where there was a discrepancy between the results of the two tests, a third EIA (Genelavia MIXT HIV1&2, Sanoi Diagnostics Pasteur SA, France) was performed. Syphilis testing on dried blood spot eluates was performed using rapid plasma reagin (RPR) and *Treponema Pallidum* Haemagglutination Assay (TPHA - Immutrep, Omega Diagnostics, United Kingdom). Presence of antibodies to *T. vaginalis* and HSV-2 were also established from dried blood spot eluates using antigen from a mycoplasma-free isolate of *T. vaginalis* (Mason et al. 2001) and glycoprotein-G antigen for HSV-2 detected using a commercial EIA kit (Gull Laboratories, Utah, USA), respectively. Urine specimens were prepared and tested for the presence of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* using a commercial ligase chain reaction (LCR) assay (Abbott LCR, Abbott Laboratories, USA). In the subsequent cohort baseline survey, diagnostic tests for STIs were limited to single antibody tests for HIV (ICL dipstick) and *Trichomonas vaginalis* (EIA) (7).

The second study was conducted in Kisesa ward in the Mwanza Region of northwest Tanzania. The ward had a population of about 20,000 people in 1994 and lies about 20 kilometres east of the regional capital Mwanza, along the main road to Kenya. Kisesa ward includes six villages, with about 40% of its population located in a roadside trading center. Since 1994, a demographic surveillance system has been in place. By the end of 1998, ten rounds had been completed, corresponding with an average interval of five months between household visits. In addition, surveys of all adults aged 15-44 and 15-46 years were carried out between August 1994 and July 1995 and August 1996 and July 1997, respectively (8). During these surveys a blood sample for HIV testing was collected. Only samples with positive results on Vironostika HIV-MIXT (Organon, Boxtel, the Netherlands) and Enzygnost HIV1/HIV2 (Behring, Marburg, Germany) were considered to be HIV positive. In the first survey all samples were also tested for syphilis using TPHA and RPR tests on whole blood samples. Data on other STIs - including gonorrhea, Chlamydia infection, trichomonas infection, and HSV-2 - are available from other studies in rural populations in the same region.

The proximate determinants conceptual framework is used to study the similarities and differences between the study populations. This conceptual framework has been used extensively in the comparative study of the influence of contextual factors on biological outcomes in populations in fertility and mortality and is also suited for STIs (9-12). Three hierarchical levels are considered for the study of factors affecting the spread of HIV. The underlying socio-demographic factors included education, mobility and marriage patterns. The proximate determinants, through which all underlying factors must operate to affect HIV transmission, included factors affecting transmission efficiency (condom use, male circumcision, other STI prevalence and treatment utilization) and those affecting the risk of exposure to an infected person (onset of sexual intercourse, sexual partnership formation and sexual mixing). Population-based HIV prevalence was used as the biological outcome.

RESULTS

Underlying population characteristics and HIV

Table 1 compares the percentage distributions of selected underlying characteristics for men and women in the two populations. The Tanzania survey had a smaller proportion of respondents in the youngest age group (15-19 for women, 17-19 for men), which is primarily due to lower participation in this age group in the Kisesa 1996-97 survey (8). The Manicaland survey had a relatively high proportion of women in the 35-44 year age group which may have been due, in part, to incorrect age reporting by older women. Educational levels were considerably higher in Zimbabwe, with almost no illiteracy and high levels of secondary education. A larger proportion of men and women had moved into the current household during the last five years in Manicaland than in Kisesa.

Much higher proportions of men and women were in marital or cohabiting partnerships in Kisesa than in Manicaland. Furthermore, married women and men were much less likely to cohabit with their spouses in Manicaland, where 10.8% of husbands and 52.9% of wives said they were not cohabiting with their spouse. The corresponding proportions in Kisesa were 0.8% and 1.6%. The proportions of men and women with a history of at least one marital dissolution were similar in both populations (about one-third of ever married respondents), but widowhood was more common in Manicaland.

Table 1 also shows HIV prevalence and age-adjusted odds ratios for HIV infection by underlying characteristic. HIV prevalence among both men and women is almost three times higher in rural Manicaland than in Kisesa. Figure 1 presents the age-specific HIV prevalence data for men and women in the two locations. HIV prevalence climbs rapidly among teenage women in Manicaland, but much less so in Kisesa, and reaches a peak at ages 26-29 years in both populations (29.3% and 10.8% respectively). Among men, the increase in prevalence in adolescence is much slower than among women in both populations and a peak is reached during the thirties, when HIV prevalence in Manicaland is four times higher than in Kisesa.

In each study, age is the strongest predictor of HIV infection status. Being divorced, separated or widowed has a significant effect on the risk of HIV infection in both locations but the effect is much stronger in Manicaland than in Kisesa. On the other hand, having as job as a professional, trader or manual laborer and being more educated is a risk factor in Kisesa but not in Manicaland. Recent in-migration is a significant risk factor in both locations. In Kisesa, HIV prevalence is much higher in the trading center than in the surrounding rural villages but this geographical difference is only evident amongst men in Manicaland.

Table 2 shows the odds ratios for HIV infection in Manicaland *versus* Kisesa calculated in three logistic regression models each for study participants and for those under 25 years of age. In the model that includes all of the underlying socio-demographic characteristics from Table 1, the odds ratios for HIV infection in Manicaland *versus* Kisesa are 6.9 and 4.8 for all men and women respectively. These ratios are substantially larger than the unadjusted odds ratios calculated in the preliminary model, especially for men. The large difference between the HIV infection levels in the two populations persists when the analysis is limited to young people (under 25).

In both populations, virtually all respondents had heard of AIDS and over 95% of men and women knew that HIV could be transmitted through sexual intercourse. In Kisesa, 58.4% of men and 77.2% of women knew that a health person could have HIV. In Manicaland, 49.0% of men and 53.0% of women said that it was not possible to tell whether a person had HIV by looks alone. There are marked differences in exposure to people who have either died from AIDS or are living with HIV. In Manicaland, all men and 99.8% of women knew someone who had HIV/AIDS while the corresponding figures for Kisesa were 42.9% and 33.4%, respectively.

Proximate determinants and HIV

Table 3 presents the distributions of sexual activity and self reported STDs in the last year. Multiple sexual partnerships were more commonly reported in Kisesa than in Manicaland, while sexual abstinence was considerably more common in Manicaland. HIV infection was rarely found in respondents who reported that they never had sex, but was elevated among women who reported no sex during the last year compared with women who reported one partner in both studies. More women in Kisesa reported multiple sexual partners in the last year than in Manicaland, a practice associated with significantly higher risks of HIV infection in both locations. Men in Kisesa had more partners in the last year than men in rural Manicaland, but in neither location was this associated with increased risk of HIV infection.

Genital ulcers were equally common in the two locations, but were only a significant risk factor for HIV infection in Manicaland. Genital discharge was almost four times more frequently reported by women in Manicaland, and in both studies women with self-reported genital discharge in the last year had significantly higher HIV prevalence than women who had no such symptoms. Seeking medical treatment for the reported genital ulcers or discharge was much more common in Zimbabwe than in Tanzania. For instance, 84% and 57% of men and women with genital discharge symptoms in Manicaland said they went to a health facility for treatment compared with 49% and 39% in Kisesa ($p < .001$ for both male and female differences between studies).

Condom use was less common in Kisesa than in Manicaland. For example, 47.0% of 115 men who had sex with a non-regular partner in Manicaland during the last two weeks indicated that they used condoms each time they had sex with a non-regular partner. In Kisesa, condoms were used in 19.3% of 1,990 non-regular partnerships reported by men for the year preceding the survey. The corresponding figures for women were 6.1% and 19.3% in Manicaland (N=57) and Kisesa (N=554) respectively.

The mean age gap between spouses was approximately six years in both populations. 55.4% of 1,586 married women in Manicaland and 58.1% of 1,438 married women in Kisesa had a husband who was at least six years older ($p > .05$). A similar age gap was also reported for non-marital partnerships in both locations. However, more of the men in Manicaland reported large age differences with non-marital partners: 56.5% of 115 men in Manicaland *versus* 42.0% of 1990 men in Kisesa reported non-marital partners who were six or more years younger than themselves ($p = .002$). 49.1% of 57 women in Manicaland and 46.9% of 554 women in Kisesa reported non-regular partnerships with men who were at least six years older ($p > .05$). Non-regular partnerships were slightly more likely to be formed away from the home area in Manicaland (31.3% and 36.8% of 115 and 57 partnerships reported by men and women, respectively) compared to Kisesa (24.9% and 24.5% of 1990 and 554 partnerships reported by men and women, respectively) ($p > .05$ for men, $p = .046$ for women).

Frequency of sex within marital unions was similar for men in both populations (10.2 and 10.8 acts of intercourse in the last month in Manicaland and Kisesa, respectively). For women, however, the corresponding means were 6.2 and 9.4 respectively, predominantly reflecting the high rates of non-cohabitation in Zimbabwe.

Information on male circumcision was not collected in Zimbabwe, as it was considered to be rare. Preliminary data from a 2001 survey indicate that prevalence is indeed low (less than 5%). In Kisesa, male circumcision was practiced by 20% of men aged 15-44 years. These were mostly men with secondary education, men living in the roadside settlement and Muslims (13).

The prevalence of sero-syphilis based on a positive RPR and a positive TPHA test, which is indicative of recent or current syphilis, was high in the Tanzanian population during the 1994-95 survey (15.0% and 11.1% among 1,647 men and 1,844 women respectively) but virtually non-existent in the Zimbabwean pilot study population (none and 0.5% among sub-samples of 119 men and 196 women, respectively). The same pattern was found in the data for history of syphilis infection (TPHA positive, RPR negative), which was ten times more common in Kisesa than in Manicaland.

For other STIs, there is some direct and indirect evidence to show that differences between rural Manicaland and Kisesa are modest. In the Manicaland pilot study, the prevalence of gonorrhoea and Chlamydia infections were 1.8% and 2.5%, respectively, among 116 men and 204 women (5). The Kisesa study did not collect similar data, but a population-based study in a nearby similar rural area reported a prevalence of the order of 0.8% and 1.5% for gonorrhoea and Chlamydia infection (14). Among antenatal women attending 12 rural health centers 2.1% and 6.6% had gonorrhoea and Chlamydia infection respectively (15).

T. vaginalis and HSV-2 prevalence rates are high in Manicaland. 1.5% (*n* = 1,634) of men and 10.7% (2,950) of women had antibodies to *T. vaginalis* infection (16) while the corresponding figures for HSV-2 were 67.5% (*n* = 77) and 51.1% (*n* = 47) (5). However, data from studies carried out in neighboring areas in the Mwanza region suggest that these STDs are also common in Kisesa: 11.0% (*n* = 980) of men tested in a population-based survey and 27.4% **(*n*=?)** of women attending antenatal clinics were found to be infected with *T. vaginalis* (15) while 26% of men (*n* = 231) and 48% of women (*n* = 259) aged 20-24 years were found to have antibodies to HSV-2 with the figure for women over 25 years of age rose to 75% (17). HPV prevalence was also found to be high (34%, *n* = 612) in a study of antenatal clinic attendees in urban Mwanza (18).

Young people

Life table analysis of current status and recall data from men and women aged 15-24 years was used to calculate the median age at first sex and first marriage. In Kisesa, median age at first sex was 16.8 years for men and 15.8 years for women, while median age at first marriage was 24.0 years and 18.6 years for men and women, respectively. In Manicaland, median age at first sex was 18.5 years for men and 18.6 years for women. Median age at first marriage was 27.7 years and 19.6 years for men and women, respectively. Figure 2 shows the gap between the first sex and first marriage is greater in Kisesa, indicating a longer period of premarital sexual activity.

The large and significant differences in the number of sexual partners reported in the last year in the adult population are also seen at ages under 25. Focusing on those who ever had sex, it is striking that a much larger proportion of single young men and women did not have sex in the last year in Manicaland compared to Kisesa (Table 4) ($p < .01$). The distributions of number of partners among those who reported sexual activity during the last year are fairly similar. The proportions of young women reporting non-regular sexual partners who were at least six years older were 53.8% in Manicaland ($n = 39$ women with a non-regular partner in the last month) and 47.4% in Kisesa ($n = 361$ women with non-regular partners in the last year) ($p > .05$). Approximately one in six young men reported a partner more than six years younger in both studies.

DISCUSSION

Dramatic differences in the extent of spread of HIV infection exist between the rural areas of Kisesa, Tanzania and Manicaland, Zimbabwe. HIV prevalence among adults is three times higher in rural Zimbabwe and this surplus becomes even greater when differences between the age structures of the two populations are taken into account. The contrast in HIV prevalence is very similar for males and females with the most striking difference being the much more rapid increase in HIV prevalence seen in the Manicaland population from the early 20s and late teens for men and women, respectively. This contrast in age-patterns of HIV prevalence provides evidence of much higher HIV incidence in young men and women in Zimbabwe. HIV incidence data are only currently available for Kisesa where the rate of new HIV infections was 8 per 1,000 person years over the period 1994-1997 (8).

It is unlikely that the gap in current HIV prevalence levels is due to differences in the timing of introduction of the virus. HIV prevalence among women attending antenatal clinics in Mwanza town near Kisesa was about 12% in 1989 and remained close to this level throughout the 1990s (19). HIV prevalence among antenatal clinic attendees in Hauna, a small rural trading center in Manicaland, and Mutare, the provincial capital, were 24% in 1994 and 25% in 1993, respectively (20). However, only 2% of (unscreened) blood donors tested at mainly urban hospitals in Zimbabwe in 1985 were HIV-positive (21), while antenatal clinic data for the 1990s show a continuing steady increase in HIV prevalence throughout the decade (22).

The large difference in HIV prevalence does not reflect differences in the distributions of underlying socio-demographic characteristics between the two populations. In fact, if the Manicaland population had the same distribution of background characteristics as the Kisesa population, HIV prevalence would have been even higher than is actually observed. Overall, the effects of the various underlying determinants on HIV prevalence were similar in the two populations. For example, marital status is an important risk factor in both populations with divorced and widowed women having very high risks of HIV infection. However, greater education, formal sector employment, and more urban residence were significant risk factors for HIV in Kisesa but had weaker effects in Manicaland. The absence of a strong association between residence in a business center and HIV infection for women in Manicaland could be because many people who live close to a tarred road and have easy access to more urban areas would have been included in the less urban category. In the broader Manicaland Study, there was a steep gradient in HIV prevalence between the more rural areas examined here and the small towns that were deliberately excluded from the current comparison.

Spatial mobility was an important risk factor for HIV infection in both studies, especially for women, with migration being more common in Manicaland. Short-term mobility is common in Kisesa - 14% of adult household residents reported sleeping elsewhere during the night preceding the interview (23) – but there were no comparable data for Manicaland. An important difference between the two populations was in the proportion of marital couples cohabiting. While this was the norm in Kisesa, more than half of currently married women in rural Manicaland reported that their husbands lived elsewhere. Most of these are believed to live in cities, towns, mines and commercial farming estates.

We also found relatively few differences in the proximate determinants of HIV infection that could contribute to the large difference in HIV prevalence between the two populations. There is no evidence that the survival of HIV infected persons varies greatly between the two populations, although better health care could lead to somewhat longer duration of infection, and thus higher prevalence levels, in Zimbabwe. If it is assumed that the duration of infection (**D**) is similar in both populations, the large difference in HIV transmission should be due to differences in the risk of exposure to an infected person (denoted as **c**) and/or to differences in transmission efficiency (**β**) (24). However, whilst several relevant differences in sexual behavior were observed between the two populations, many of these actually point to higher levels of risk behaviors and HIV transmission in the Tanzanian population.

Age at first sexual intercourse was younger on average in Kisesa than in Manicaland and the gap between first sex and first marriage was longer and premarital sex was much more common. More men and women in Kisesa reported multiple sexual partnerships both before and after marriage. Patterns of sexual partner selection (mixing) between different population sub-groups can also affect the spread of HIV. There was no evidence for differences in age mixing between the two populations but the higher levels of mobility and spousal separation in rural Zimbabwe may have led to more contact with high risk groups including sex workers in urban and commercial areas. HIV prevalence is also much higher in urban areas in Zimbabwe so more extensive urban-rural transmission of HIV is a possibility.

The limited evidence for greater exposure to HIV infection in Manicaland could reflect problems of measurement. Several studies have recorded limitations in the validity of self-reported survey data on sexual behavior (25-27). However, there is little reason to suspect that the Kisesa partnership data are severely affected by gross over-reporting. Surveys in 1994-95, 1996-97 and, subsequently, in 1999-2000 produced similar results despite the presence of AIDS awareness campaigns aimed at limiting multiple partnerships and promoting condom use. The absence of an association for men in Kisesa between number of sexual partners in the last year and risk of HIV infection could reflect exaggeration of numbers of sexual partners but results from a more detailed analysis of the data suggest that such over-reporting is limited (26). More plausibly, the Zimbabwean respondents could have seriously under-reported their sexual activity. A number of steps were taken to restrict interview bias including the use of an informal confidential voting interview (ICVI) procedure in two-thirds of the interviews to enhance privacy on reporting of multiple partnerships (28). The internal consistency of the data suggests that data quality is reasonable. For example, HIV prevalence among respondents who reported not yet having started sex was relatively low (6) - only slightly higher than in Kisesa – and there was a strong and consistent association between number of reported lifetime partners and chance of being HIV positive (29).

Three factors affecting transmission efficiency were considered: condom use, the prevalence of other STIs, and male circumcision practices. Men and women in Manicaland both reported greater condom use in non-marital non-cohabiting partnerships than their counterparts in Kisesa. Nearly half of the men with non-regular partners in Manicaland said they always used condoms with such partners. It is difficult to draw firm conclusions from self-reported condom use data as previous studies have shown that reporting of condom use is subject to bias. However, what matters in a comparative study such as this is whether the bias differs between the two populations and we have no evidence that respondents in the Manicaland study felt more ‘obliged’ to report condom use than those in Kisesa. A second concern is that the large difference in reporting of multiple sexual partners in the last year could be due, at least in part, to greater under-reporting of non-regular partners in Zimbabwe. If non-regular sexual partners with whom condoms are used are more likely to be reported than other partners, condom use rates would be biased upwards. However, we have no means of assessing the extent of this bias.

The comparison of the prevalence of other STIs was incomplete and relied in part on data from neighboring populations with similar characteristics. A number of STIs were common in both populations with prevalence levels typically being of the same order of magnitude. However, positive serological tests for recent or past syphilis were much more common in Kisesa. Prevalence of HSV-2 infection was high in small samples of men and women in Manicaland but there was also evidence of high levels of this infection in rural areas close to Kisesa (17).

Male circumcision is unusual in Manicaland. Whilst it is more widely practiced in Kisesa, the prevalence level (one in five men) does not suggest that this could be a major factor in explaining the differential spread of the HIV epidemic between Manicaland and Kisesa. Indeed, the male circumcision rate in Kisesa is lower than that recorded in Kisumu, Kenya (27.5%), one of the high HIV prevalence sites in the Four Cities Study where HIV infection levels were comparable to those seen in Manicaland - 19.8% in men and 30.1% in women (30).

The principal limitation of the comparative analysis of local determinants of HIV infection presented in this paper is the reliance on single round cross-sectional HIV prevalence data. The data on many of the underlying socio-demographic factors and proximate determinants describe the situation close to the time of the survey, while the HIV prevalence data are the result of exposure to risk factors over periods of a decade or more. At the population level, current HIV prevalence levels in countries such as Tanzania and Zimbabwe reflect patterns of transmission over even longer timescales. During this time, the prevalence of some of the key proximate determinants is liable to be reduced particularly where epidemics are severe. As a consequence, the frequency distributions of some of the underlying factors will also change and associations between these underlying factors and proximate determinants may weaken.

This can be for several inter-related reasons (31): AIDS mortality is initially highest amongst those who are subject to greater exposure to HIV infection in the early years of an epidemic. Thus people with very high numbers of sexual partners and high levels of infection with other STIs may become less common within the population. This, in turn, alters the sexual activity distribution within the population reducing the availability of partnerships with high-risk individuals. At the same time, HIV gradually spreads through the local sexual network so that those with intrinsically less risky lifestyles can become at progressively greater risk of exposure to previously infected partners. Finally, sexual and health seeking behavior may change more rapidly in a population subject to a major HIV epidemic. This would reduce the prevalence of intrinsically high-risk behavior within the population as a whole but could also affect the relative strength of underlying socio-demographic risk factors for HIV infection. For example, greater education may initially be associated with enhanced risk of HIV infection in a population but the direction of association could reverse over time if more educated people adopt safer behaviors faster than their less educated counterparts (32).

Similar difficulties were encountered in interpreting the results of the Four Cities Study. A simulation procedure to adjust the sexual activity levels of oldest cohorts was used to take account of the effects of AIDS-selective mortality and are more reflective of recent risks (24). However, the adjusted rates of lifetime partnership formation were still no higher in the lower HIV-prevalence cities than in those with high HIV prevalence. Our own findings on underlying socio-demographic and proximate determinants of HIV in Kisesa and Manicaland were also little changed when the analysis was restricted to young people who would be less directly affected by AIDS-selective mortality. HIV prevalence remains much higher at young ages in Manicaland despite lower levels of sexual partner change. One contributory factor could be the pattern of sexual mixing that continues to put young women at risk of infection from older partners whose cumulative exposure to HIV infection is extremely high.

In Manicaland, where HIV prevalence has reached much higher levels, AIDS-related mortality has been far more pronounced (33) and almost all respondents knew someone who had died of HIV/AIDS. In Kisesa, just over one-third of respondents reported such exposure. Therefore, there must be a possibility that changes in behavior have been more extensive in Manicaland. This would be consistent with the higher level of condom use with non-regular partners reported in Manicaland. A comparison of findings from the Zimbabwe DHS surveys conducted in 1989, 1994 and 1999 suggests little change in age at first sex and levels of multiple partnerships, but some increase in condom use with non-marital partners during 1994-99 (34).

Overall, the comparison of data on a wide range of contextual and proximate factors for the rural populations in Kisesa, Tanzania, and Manicaland, Zimbabwe, has resulted in few possible reasons for the much more extensive pattern of HIV transmission seen in Zimbabwe. Later marriage, less frequent cohabitation among marital partners, higher levels of spatial mobility, lack of male circumcision, and, possibly, higher incidence of HSV-2, are possible contributory factors. However, there are at least as many factors that point to lower HIV transmission in Manicaland compared to Kisesa. Differences between study sites in the reliability of reporting may have distorted the ecological comparison of sexual behavior. In the Four Cities Study, the high HIV prevalence cities were found to be characterized by earlier sexual debut, earlier marriage, and larger age difference between spouses in comparison to the low HIV prevalence cities. However, these behavioral factors were found to be less important determinants of the size of HIV epidemics than factors affecting transmission efficiency – male circumcision, HSV2 and, to a lesser extent, syphilis (3,4). Our comparison of two rural populations found little evidence to support these hypotheses. The most important differences between the two populations pertained to underlying socio-demographic variables such as the much lower levels of spousal cohabitation and the higher levels spatial mobility seen in Manicaland, although these differences did not translate into measurable changes in the proximate determinants.

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Table 1: Percent distribution of underlying determinants and HIV seroprevalence by underlying determinants, with age-adjusted odds ratios, men 17-44 and women 15-44 years, Manicaland, 1998-2000 and Kisesa 1996-1997.

	Manicaland (N=1,624)			Kisesa (N = 2,588)		
MEN	Percent distribution	Percent HIV +	Age-adjusted OR (95% CI)	Percent distribution	Percent HIV +	Age-adjusted OR (95% CI)
Total	100.0	15.4		100.0	5.3	
Age (years)						
17-19	32.5	0.8	0.1 (0.03 – 0.3)	22.5	0.3	0.2 (0.04 – 0.7)
20-24	28.4	7.4	1.0	23.8	2.1	1.0
25-29	16.6	23.3	3.8 (2.4 – 6.0)	18.7	7.9	4.0 (2.1 – 7.5)
30-34	9.1	41.2	8.8 (5.5 – 14.2)	14.7	11.0	5.7 (3.0 – 10.9)
35-44	13.4	40.4	8.5 (5.5 – 13.2)	20.4	7.8	3.9 (2.1 – 7.4)
Marital Status						
Never married	68.6	6.6	1.0	45.9	2.2	1.0
Monogamous	24.0	31.3	1.3 (0.97-2.0)	43.9	7.5	1.0 (0.6 - 1.7)
Polygamous	1.9	40.0	1.9 (0.8-4.3)	4.6	9.3	1.2 (0.5 - 2.7)
Divorced/separated	4.5	43.8	2.7 (1.5-4.8)	5.4	9.3	1.4 (0.7 - 2.9)
Widow	1.1	64.7	4.8 (1.6-13.8)	0.3	12.5	1.9 (0.2 – 16.4)
Education						
None	0.3	0.0	1.0	27.0	4.7	1.0
Primary	22.7	22.5	1.0	68.6	5.6	1.4 (0.9-2.7)
Secondary	77.0	13.4	1.2 (0.9-1.5)	4.4	2.6	0.5 (0.1-1.6)
Type of work						
Farmer/student/unemployed	78.7	14.5	1.0	83.2	4.5	1.00
Professional/trader/manual laborer	21.3	18.8	1.2 (0.9-1.8)	16.8	9.2	1.7 (1.2-2.5)
Mobility (years in household)						
≥ 15 years	76.0	15.5	1.0	85.8	4.9	1.00
5-14 years	7.8	17.5	1.2 (0.8 – 1.6)	8.1	5.5	1.1 (0.6 – 1.9)
< 5 years	16.3	10.5	2.0 (1.4 – 2.7)	6.1	8.6	1.2 (0.8 – 1.8)
Type of sub-village						
Rural	83.7	14.4	1.0	66.9	3.4	1.0
Business centre	16.3	20.5	1.9 (1.3-2.8)	33.1	9.0	3.1 (2.1 - 4.4)
	Manicaland (N=2,968)			Kisesa (N = 3,365)		
WOMEN	Percent distribution	Percent HIV +	Age-adjusted OR (95% CI)	Percent distribution	Percent HIV+	Age-adjusted OR (95% CI)
Total	100.0	21.1		100.0	8.0	
Age (years)						
15-19	24.2	4.9	1.0	19.3	2.3	1.0
20-24	17.9	20.8	5.1 (3.4 – 7.6)	23.5	7.8	3.6 (2.0 – 6.4)
25-29	15.1	38.1	12.0 (8.1 – 17.7)	19.4	13.7	6.7 (3.8 – 11.7)
30-34	12.5	33.4	9.8 (6.6 – 14.7)	15.5	10.0	4.7 (2.6 – 8.4)
35-44	30.3	20.7	5.1 (3.5 - 7.4)	22.4	6.1	2.9 (1.6 – 5.2)
Marital Status						
Never married	26.0	6.7	1.0	18.5	3.9	1.0
Monogamous	57.2	20.0	1.6 (1.1 – 2.3)	55.1	6.7	0.8 (0.5 – 1.4)
Polygamous	-	-	-	15.3	8.2	1.0 (0.6 – 1.9)
Divorced/separated	8.8	42.9	4.5 (2.9 – 7.0)	9.6	18.3	2.6 (1.5 – 4.7)
Widow	8.0	51.9	8.2 (5.1 – 13.1)	1.6	27.8	4.9 (2.2 – 10.9)
Education						
None	2.4	26.8	1.0	45.6	5.5	1.0
Primary	40.3	24.4	1.0	52.1	9.7	1.9 (1.4 – 2.5)
Secondary	57.4	18.5	0.8 (0.6 – 0.9)	2.4	11.4	2.1 (1.0 – 4.4)
Type of work						
Farmer/student/unemployed	94.1	20.8	1.0	91.6	7.1	1.0
Professional/trader/manual laborer	5.9	25.1	1.2 (0.9 – 1.8)	8.4	15.9	2.4 (1.7 – 3.5)
Mobility (years in household)						
≥ 15 years	58.8	19.2	1.0	67.7	6.5	1.0

5-14 years	17.0	21.3	0.7 (0.5 – 0.9)	18.6	9.2	1.2 (0.8 – 1.6)
< 5 years	24.3	25.5	1.4 (1.1 – 1.7)	13.7	13.7	2.0 (1.4 – 2.7)
Type of sub-village						
Rural	97.0	21.1	1.0	60.4	4.8	1.0
Business centre	3.0	21.4	1.1 (0.6 – 1.9)	39.6	12.4	2.7 (2.1 – 3.6)

Table 2

Odds ratio of HIV (with 95% confidence limits) in Manicaland compared to Kisesa (reference) for all men and women and for men and women under 25 years of age before and after controlling for age and for other socioeconomic and demographic characteristics in a logistic regression model.

Model	Men (all)	Women
Study only	3.3 (2.6 – 4.1)	3.1 (2.7 – 5.7)
Study, age	5.2 (4.1 – 6.6)	3.7 (3.2 – 4.3)
Study, age and other variables	6.9 (4.9 – 9.8)	4.8 (3.6 – 6.3)
	Men (<25)	Women (<25)
Study only	3.2 (1.7-5.8)	2.3 (1.7 –3.1)
Study, age	3.5 (1.9 – 6.4)	2.9 (2.1 – 3.8)
Study, age and other variables	5.6 (2.2 – 14.3)	5.4 (3.2 – 8.9)

Table 3
Percent distribution of proximate determinants and HIV seroprevalence by proximate determinants, with age-adjusted odds ratios, men 17-44 years, Manicaland, 1998-2000 and Kisesa 1996-1997.

MEN	Manicaland (N=1,624)			Kisesa (N = 2,588)		
	Percent distribution	Percent HIV positive	Age-adjusted OR (95% CI)	Percent distribution	Percent HIV positive	Age-adjusted OR (95% CI)
Total men	100.0	15.4		100.0	5.3	
Partners in last year						
Never sex	24.7	1.0	0.0 (0.0 – 0.1)	7.8	0.0	-
None	14.8	13.3	0.5 (0.3 – 0.7)	1.6	10.0	1.8 (0.6 – 5.2)
1	30.3	24.0	1.0	39.8	5.8	1.0
2	12.5	18.8	0.7 (0.5 – 1.1)	21.3	7.1	1.2 (0.8 – 1.9)
3 or more	17.8	20.1	0.8 (0.6 – 1.1)	29.4	4.3	0.7 (0.5 – 1.1)
Genital ulcer in last year*						
No	88.3	11.3	1.0	88.1	5.1	1.0
Yes	11.7	46.3	3.6 (2.5 – 5.2)	11.9	6.5	1.2 (0.7 – 1.9)
Genital discharge in last year*						
No	93.1	13.1	1.0	89.0	4.9	1.0
Yes	6.9	46.4	3.4 (2.2 –5.4)	11.0	8.0	1.5 (1.0 – 2.5)

WOMEN	Manicaland (N=2,968)			Kisesa (N = 3,365)		
	Percent distribution	Percent HIV positive	Age-adjusted OR (95% CI)	Percent distribution	Percent HIV positive	Age-adjusted OR (95% CI)
Total women	100.0	21.1		100.0	8.0	
Partners in last year						
Never sex	19.3	1.2	0.1 (0.0 – 0.2)	6.1	0.5	0.2 (0.0 – 1.3)
None	17.5	35.1	2.1 (1.7 – 2.6)	1.7	22.8	4.7 (2.4 – 9.0)
1	60.7	22.1	1.0	83.9	7.4	1.0
2 or more	2.6	49.4	3.8 (2.3 – 6.1)	8.3	14.3	2.4 (1.6 – 3.4)
Genital discharge in last year*						
No	75.3	17.1	1.0	93.6	7.4	1.0
Yes	24.7	33.2	2.0 (1.7 – 2.5)	6.4	14.8	1.9 (1.3 – 2.9)

* Analysis of symptoms of genital discharge and genital ulcers limited to those who had sex in the last year.

Table 4
Percent distribution of number of sexual partners in the last year among never married men and women under 25 years of age who ever had sex, Manicaland and Kisesa

	Men		Women	
	Manicaland	Kisesa	Manicaland	Kisesa
N of respondents	549	814	153	383
None	25.7	3.7	50.3	4.7
1 partner	25.7	39.1	39.2	73.1
2 partners	18.8	18.3	6.5	6.5
3 or more partners	29.9	38.9	3.9	4.7
Total	100.0	100.0	100.0	100.0

FIGURE CAPTIONS

FIG 1. HIV prevalence by age and sex, Kisesa, Tanzania, 1996-97 and Manicaland, Zimbabwe, 1990-2000

FIG 2. Proportions having started sexual intercourse and been married by age and sex, Kisesa, Tanzania, 1996-97 and Manicaland, Zimbabwe, 1990-2000

Figure 1
HIV prevalence by age and sex

Kisesa and Manicaland

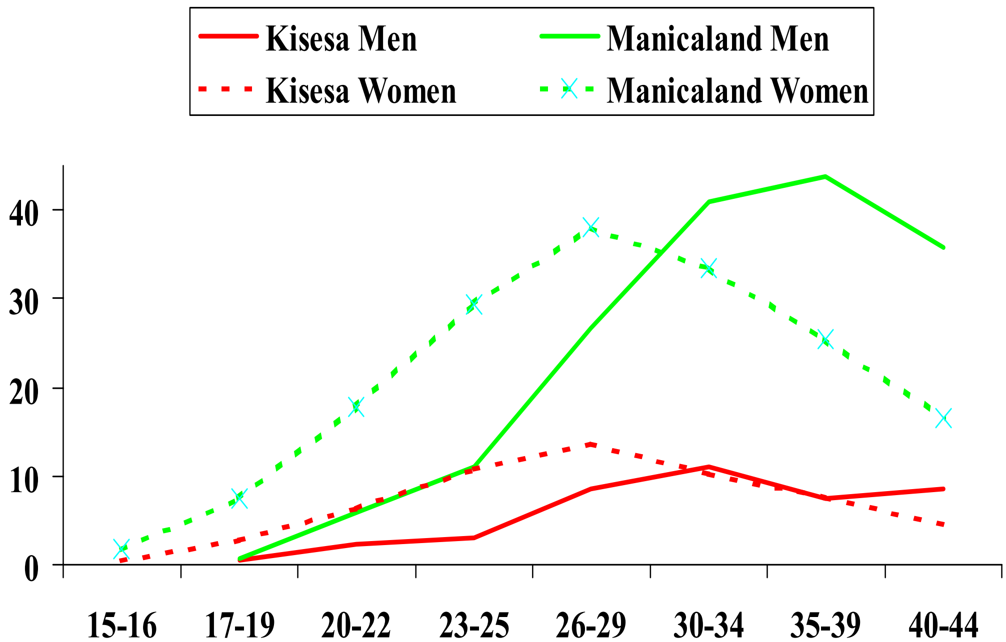

Figure 2a
Age at first sex and age at first marriage by age,
men 15-24, Kisesa and Manicaland

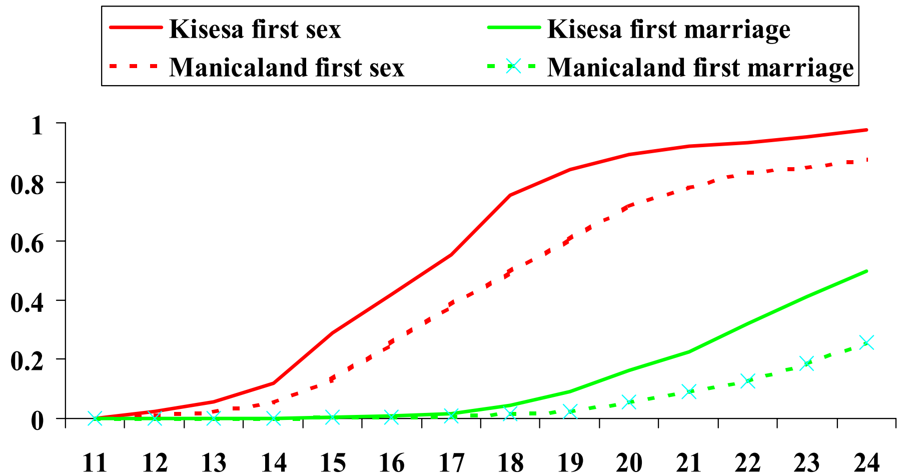

Figure 2b
Age at first sex and age at first marriage by age,
women 15-24, Kisesa and Manicaland